

On the issue of air pollution in the Krasnoyarsk Territory

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Abstract. This article presents the results of the study of problems of air pollution in the Krasnoyarsk Territory. The study determines the factors and conditions affecting the state of local atmospheric air, provides a list of key pollutants detected in the air of the territory and their percentage established during environmental screening. The paper outlines the main issues associated with environmental screening of the state of atmospheric air in the Krasnoyarsk Territory, presents data of dynamic observations of air quality in large urban agglomerations of the Krasnoyarsk Territory, emission volumes, and other indicators of air purity. Moreover, the author draws considerable attention to the list of economic spheres of regional development that are responsible for the greatest anthropogenic impact on the atmospheric environment. The study also provides a list of specific enterprises and organizations that are responsible for the largest amount of atmospheric emissions in the Krasnoyarsk Territory. The reasons for the growing anthropogenic influence on the state and quality of atmospheric air of the Krasnoyarsk Territory are determined: in particular, due to the local rich natural resources, water and forest resources, the extraction and processing of which is a priority component of the economy of the Krasnoyarsk Territory.

1 Introduction

The relevance of the research topic is due to modern trends in the implementation of environmental state screening in the regions of the Russian Federation. We should note that the problems of global changes in the biosphere, and air as its structural element, are studied by many scientists from around the world [1]; also, various intergovernmental research groups of expert scientists are being created to study these issues at the interstate level and formulate the main problems of air pollution that humanity may face in the coming decades [2, 3]. Meanwhile, the formulated forecasts vary in their evaluation of consequences and spring heated discussions in various research circles [4, 5].

At the same time, it is quite obvious that the anthropogenic influence of humans on biosystems – and air in particular – is increasing [6], the population is growing, industrial production is becoming more complex and larger in size, the volume of extraction and use of exhaustible natural resources is snowballing. All this requires increased attention and determination of the degree of impact on the biosphere, calculation of the rate of consumption

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of minerals and resources that allows nature to self-heal and reproduce in the required quantities and quality characteristics.

At the same time, the issues of air pollution in different regions of the Russian Federation are not solved identically, and they are especially relevant in the areas with developed industrial production. The Krasnoyarsk Territory belongs to this category – it is one of the most industrially developed subjects [7], with its extraction and processing of non-ferrous metals and other minerals, hydro- and electric power complexes, forestry, woodworking industry, mechanical engineering and other industrial sectors of the economy actively developing.

It should also be noted that the region is one of the largest transport hubs and is a transit hub of the entire Siberian Federal District.

Considering the above features of the Krasnoyarsk Territory, the degree of anthropogenic influence on the air pollution of the region increases from year to year [8].

In addition to these circumstances, we believe that consideration of the issues of atmospheric air pollution of the Krasnoyarsk Territory, a constituent entity of the Russian Federation, seems very relevant, since in the end, the problems of air quality as an integral part of the biosphere require a custom approach [9], calling for optimal interaction with the air environment, which ensures the well-being and safety of the population.

2 Purpose of the study

The main purpose of our study is to consider the issues of air pollution in the Krasnoyarsk Territory, as well as to study the specifics of the influence of anthropogenic factors on the state of the atmosphere in the region.

3 Research questions

The study will provide answers to the following questions:

1. Which factors and conditions affect the state of the air environment of the Krasnoyarsk Territory?
2. What are the main elements that pollute the atmosphere of the Krasnoyarsk Territory?
3. How is the screening of the state of atmospheric air in the territory of the region under study carried out?
4. What is the state of the atmosphere of the Krasnoyarsk Territory, emission volumes and other indicators in dynamic observation?
5. What are the main objects of anthropogenic impact that pollute the atmospheric air?

4 Research methods

Research methods used during the work:

- In our research, we applied theoretical methods of systemic, logical and comparative analysis of scientific literature, analysis and comparison of the results of air pollution in the Krasnoyarsk Territory.

5 Results and discussion

Starting the study, it is necessary, in our opinion, to most accurately determine the factors that significantly affect the state of atmospheric air in the Krasnoyarsk Territory, having the greatest negative impact on the quality of the regional air environment.

Among the reasons that stimulate these processes is the increase in the scale of industrial production, which is constantly expanding due to the growing need for products of ferrous and non-ferrous metallurgy [10]. Also, among the causes of air pollution, we can identify significant wear and obsolescence of dust collecting and gas separating equipment – and other types of equipment, which purify the industrial air emitted into the atmosphere from harmful impurities and particles – used in existing industrial and processing enterprises.

Another factor that significantly affects the purity of the air in the region is the constantly growing number of residents [11], which causes the following processes:

- growth of urbanization of the Krasnoyarsk Territory due to an increase in the size and number of urban agglomerations;
- increase in the number of private vehicles of residents, which is not environmentally friendly and is a source of a significant portion of emissions into the atmosphere [12];
- insufficient growth rate of green spaces, clearing the air environment of urban agglomerations.

In addition to these reasons, we should note the unfavorable meteorological conditions of the territory, which contribute to the accumulation and dispersion of harmful chemical compounds due to the significant repetition and power of surface and elevated inversions and weak wind processes.

Thus, these circumstances significantly determine the quality of atmospheric air throughout the region – and in urban agglomerations in particular – since these factors are primarily associated with urbanized areas, where the impact of anthropogenic influence on the biosphere is maximal [13].

Further, we will move on to the next question of our study and determine which harmful substances are present in the air of the Krasnoyarsk Territory.

Among the substances that cause air pollution in the Krasnoyarsk Territory are suspended substances in the form of undifferentiated dust particles. Their main sources of emissions are thermal power plants, metallurgical enterprises, municipal and industrial boiler houses [14].

Another polluting element is sulfur dioxide, the emissions of which are carried out by enterprises of non-ferrous metallurgy and the thermal power sector.

Hazardous air pollutants that are found in significant quantities in the atmosphere of the region under study also include nitrogen dioxide, nitrogen oxide, phenol, formaldehyde, ammonia, hydrogen sulfide, hydrochloride, hydrofluoride, benzene, xylene, toluene, ethylbenzene, sulfur dioxide.

In the vast majority of cases, exceeding the maximum permissible concentrations of these pollutants is associated with anthropogenic impact on the biosphere, including the air environment, of industrial and thermal power enterprises, as well as organizations of the public sector.

Since air pollution occurs systematically, taking into account the ever-increasing anthropogenic impact on the atmosphere, in the Krasnoyarsk Territory, a constituent entity of the Russian Federation, the level of atmospheric air pollution is constantly screened to quantify air pollution and determine the qualitative composition at 128 monitoring posts [15]. At the same time, not all the posts are stationary. Ninety-eight of these posts are routed with different software for collecting air samples. These posts are located in 9 urban districts and 7 municipal districts of the Krasnoyarsk Territory. At the same time, the largest number of stationary posts (15 units) is located in Krasnoyarsk, 4 in Achinsk, 3 in Kansk, 2 in Nazarovo and Lesosibirsk, 1 each in ZATO Zelenogorsk, Berezhovskiy and Yemelyanovskiy districts. In total, there are 30 stationary observation posts.

In Figure 1, we present the dynamics of pollutant emissions into the air of the Krasnoyarsk Territory, including emissions from the Norilsk Industrial District.

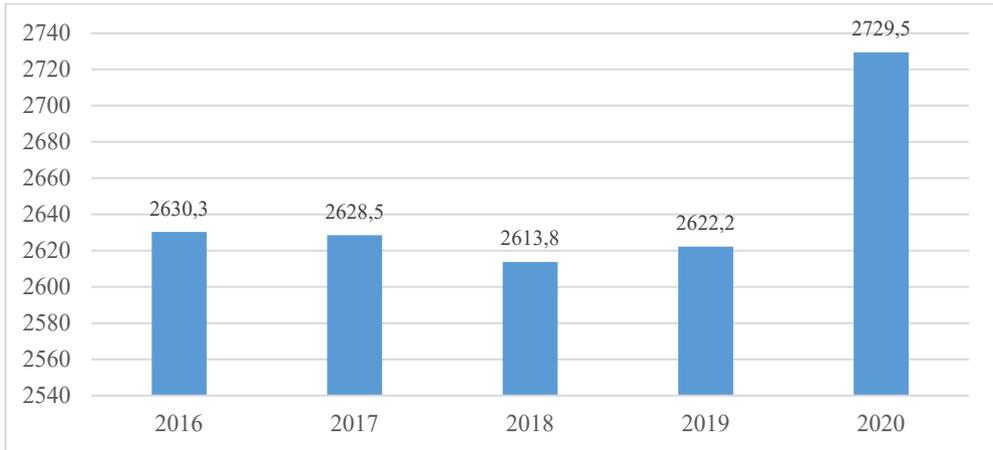


Fig. 1. Total emissions from all sources, thousand tons.

From the data presented, we can clearly see that during 2016–2019, the volume of total emissions into the atmosphere was stable, and in 2017 and 2018 it even slightly decreased. However, in 2020 we can observe their growth, respectively, the emission indicators of 2020 exceeded the value of all previous years.

In the following Figure 2, we present data on the dynamics of the ratio of emissions of pollutants into the air of the Krasnoyarsk Territory, taking into account the source of pollution (stationary or non-stationary sources).

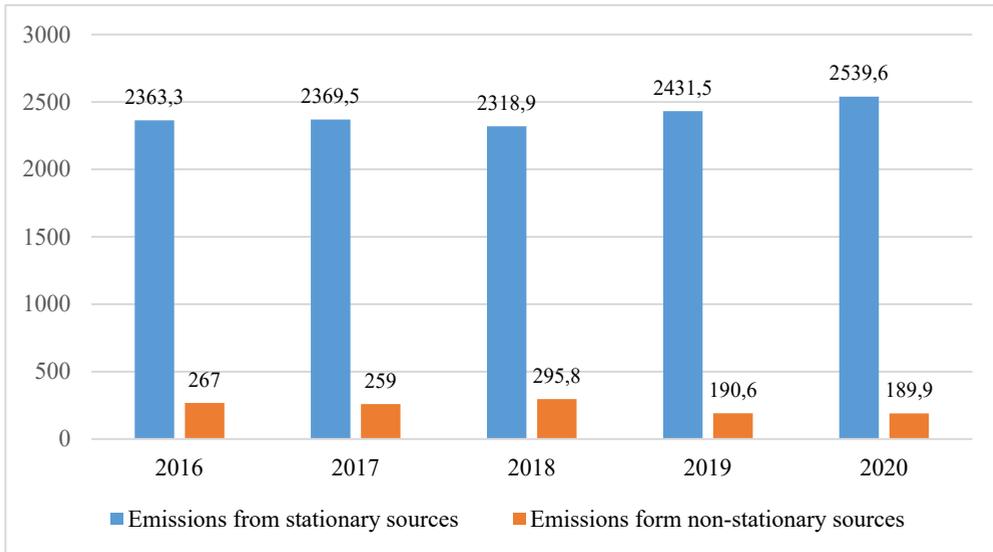


Fig. 2. Ratio of atmospheric emissions from stationary and non-stationary sources, thousand tons per year.

The data provided in the Figure 2 allow us to observe an increase in pollutant emissions from stationary sources in 2020, which is most likely due to the development of the oil and gas industry in the Norilsk industrial district of the Krasnoyarsk Territory. In addition, it is obvious that the bulk of pollutant emissions into the atmosphere of the region is carried out by stationary sources (enterprises and organizations).

We also consider it necessary to provide data on the composition of emissions produced by stationary sources of pollution and their ratio (in percent). We clearly display these data in Figure 3.

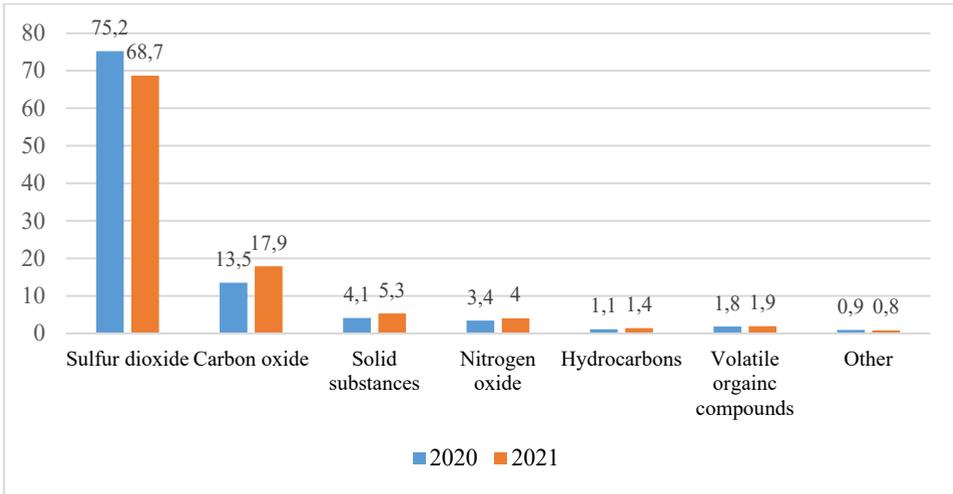


Fig. 3. Composition of emissions from stationary sources, 2020–2021, %.

From these data, it is clear that the main emissions are associated with the release of sulfur dioxide into the atmosphere, carbon monoxide occupies the second place in terms of emissions, emissions of solid substances are in third place; while there is a decrease in sulfur dioxide emissions, there is an increase in emissions of all other pollutants listed.

From the above we should conclude that the anthropogenic impact on the atmosphere of the Krasnoyarsk Territory is quite high.

The ongoing screening carried out in the main large cities of the region, presented by us in Figure 4, describes air pollution level as "High" and "Very high". This level of pollution is determined by calculating a comprehensive air pollution index for 5 main pollutants for cities (further abbreviated as API). The gradation of the index values is as follows:

- low level of pollution: API value of 0–4 units;
- elevated level of pollution: API value of 5–6 units;
- high level of pollution: API value of 7–13 units;
- very high level of pollution: API value in excess of 14 units.

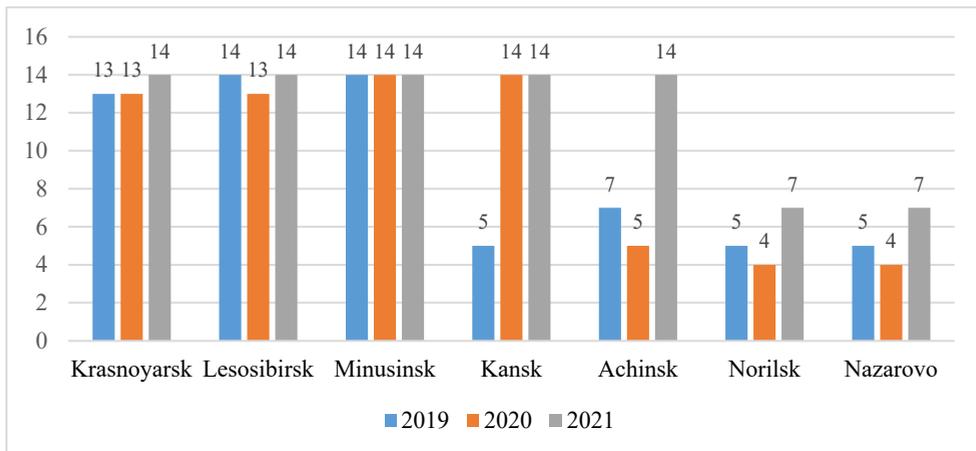


Fig. 4. API in the large cities of the Krasnoyarsk Territory, 2019–2021.

Thus, taking into account the data provided, in 2021 in Krasnoyarsk, Lesosibirsk, Minusinsk, Kansk, and Achinsk, a very high level of pollution was recorded. And in the cities

of Krasnoyarsk, Lesosibirsk, and Minusinsk, high and very high levels of air pollution have persisted over the past three years.

In addition, it should be noted that currently in the Krasnoyarsk Territory there are 6 051 facilities that have a negative impact on the state of the environment, including atmospheric air, the main sources of pollution of which are primarily the facilities of the Norilsk Industrial District.

It is also necessary to identify the main enterprises and organizations that produce the largest amount of emissions into the air environment of the region. These include the Polar Branch of PJSC MMC Norilsk Nickel; JSC RUSAL Krasnoyarsk; JSC Nazarovskaya GRES; Krasnoyarsk GRES-2, Branch of JSC Yenisei TGC (TGC-13); JSC RUSAL Achinsk; LLC PH-Vankor; JSC Polyus Krasnoyarsk; Branch Berezovskaya GRES of PJSC Unipro; JSC Krasnoyarsk CHPP-1; JSC Atyrau Refinery VNK (Achinsk Oil Refinery); Krasnoyarsk CHPP-2, Branch of JSC Yenisei TGC (TGC-13); Krasnoyarsk CHPP-3, Branch of JSC Yenisei TGC (TGC-13).

In general, it should be noted that the Krasnoyarsk Territory has a developed industry, which is due, among other things, to the fact that the territory is rich in various natural resources, water and forest resources. This circumstance significantly affects the state of atmospheric air in the region.

6 Conclusions

The state of air environment in the Krasnoyarsk Territory is determined by a consistently high degree of pollution as a result of exceeding the permissible levels for individual pollutants in large urban agglomerations of the region, such as Krasnoyarsk, Lesosibirsk, Minusinsk, Kansk, Achinsk, Norilsk, and Nazarovo.

The main reasons for the increased level of atmospheric air pollution in the Krasnoyarsk Territory are: increase in the scale of industrial production, which is constantly expanding, due to the growing need for products of ferrous and non-ferrous metallurgy, significant wear and obsolescence of dust collecting and gas separating equipment – and other types of equipment, which purify the industrial air emitted into the atmosphere from harmful impurities and particles – used in existing industrial and processing enterprises, and constantly growing number of residents.

According to the results of the data provided in the study, an increase in pollutant emissions from stationary sources is recorded in 2020, which is happening with a high degree of probability due to the development of the oil and gas industry in the Norilsk industrial district of the Krasnoyarsk Territory.

The main emissions are associated with the release of sulfur dioxide into the atmosphere, carbon monoxide occupies the second place in terms of emissions, emissions of solid substances are in third place; while there is a decrease in sulfur dioxide emissions, there is an increase in emissions of all other pollutants listed.

Anthropogenic impact on the state of the atmosphere in the region is rather high and is constantly growing due to the fact that the territory is rich in various natural resources, water and forest resources, the extraction and processing of which is a priority component of the economy of the Krasnoyarsk Territory.

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